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CONTENTS.

QUERY.

Can any reader of *Science* cite a case of lightning stroke in which the dissipation of a small conductor (one-sixteenth of an inch in diameter, say,) has failed to protect between two horizontal planes passing through its upper and lower ends respectively? Plenty of cases have been found which show that when the conductor is dissipated the building is not injured to the extent explained (for many of these see volumes of Philosophical Transactions at the time when lightning was attracting the attention of the Royal Society), but not an exception is yet known, although this query has been published far and wide among electricians.

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N. D. C. HODGES, 874 BROADWAY, N. Y.

SCIENCE

NEW YORK, OCTOBER 27, 1893.

THE VISITORS TO ONE OAK TREE.

BY MORRIS GIBBS, KALAMAZOO, MICH.

ONE of the pleasures in the study of nature is in keeping a correct record of one's observations for a series of years. Twenty five years ago the writer began a record or list of the birds, mammals and insects seen in a village yard. The lot is five by twelve rods in size, and within this area and over it there have been seen one hundred and thirty-four species of birds, the large majority of which were recorded during the migrations. Of this number nineteen species have been found breeding in the lot.

In this yard are a variety of trees and shrubs, a boundary evergreen hedge, and just outside of it are many surrounding trees. These trees afford resting places for many birds, and during migrations most of those birds which pass through our city of 20,000 inhabitants, usually visit our yard. There is one tree in particular in the lot, a thickly foliaged, low-spreading Burr Oak, *Quercus macrocarpa* well covered with a netting of the common creeper of this section *Ampelopsis quinquefolia,* to which the birds are especially attracted.

During the last decade many changes have taken place in our city lot and the attractions for migrants are not as many as formerly, and furthermore, the former quiet village, now a thriving city, is not invaded by as many of the feathered tribe, as the active migrants prefer the suburbs in their seasonal journeyings. Nevertheless, as the following observations show, many kinds of birds wander into the city, while a few of our commoner species make their home in our midst; some as summer sojourners and others as regular residents or winter visitors.

The oak tree to which I refer stands in our front yard and is readily inspected from the house veranda. At times the tree is alive with birds, and I have often seen three to five species in the branches at once, and on one occasion seven species, including bluejay, robin, yellow-rump, and Tennessee warblers, bronzed grackle, chipping and the ubiquetous European sparrow. The following sixty-four species have been identified while in the branches of the burr oak:

A score of years or more ago the wild or passenger pigeon was known to alight in this tree. The sharp-shinned hawk once accidentally selected the oak in the autumn for a place of observation in his admirable warfare on the pertinacious imported sparrow. Those peculiar and mysterious birds commonly known as rain crows, or more intelligently as cuckoos, are occasional summer visitors, the black-billed quite commonly, while the rarer species, the yellow-billed has been seen but once, but it is becoming more common hereabouts.

Of the wood peckers, five have been seen, the yellow-bellied appears in April and stays a month; red-head and golden-wing straggle into the city and to our tree irregularly from March to November. The hairy and downy wood peckers are not rarely observed spring and fall, the latter often in winter.

Others who visit the oak along with the wood peckers and who feed on much the same kind of food taken from the crevices of the rough bark, are the nuthatches, the white-breast being a resident while the red-belly is a straggler from the north. That mite of flesh and blood, the brown creeper, searches the trunk from base to main fork, and is seen off and on from November to April, often in company with the titmouse or common chickadee. Two other diminutive birds, but not quite so hardy, are the golden and ruby-crowned kinglets which are regular spring and fall visitors.

A not rare winter visitor is the common red crossbill of the north, which occasionally alights in flocks in our oak, and flocks of red polls often come to town. Still another not always recognized northern bird is the little pine siskin, while I have seen the even less known pine and evening grosbeaks. I have also observed the great northern shrike or butcher-bird. The bluejay is a resident and is seen every month in the tree without an exception. The goldfinch is also a resident but is noticed more often in the oak during summer. Snow birds of the slate-colored species and tree sparrows are seen in fall, winter and spring, the former commonly, the latter rarely about our oak. The cedar bird, a resident, yet so erratic in its appearance, may be seen in summer or winter, but never singly, and never to be relied upon.

In the early spring, often in late February the robin and blue bird lend their presence, the former caroling from the topmost branches of the still bare-limbed tree.

The next thrush to show itself is the hermit, which, though usually a ground species, sometimes flies into the lower branches on its way north. Sometimes a cat bird has visited the oak. I once heard a veery's song in the tree, and a dead specimen of the olive-backed thrush lying beneath the branches proved that an unfortunate example of this retiring species had taken the city route and probably been sacrificed to the skill of a boy with an air-gun or sling shot.

Among the spring sparrows I have seen the purple finch, which with the song sparrow often appear before the snow is gone, after which the little hair bird or chippy shows itself. Then follows the white-throated sparrow with its beautiful song which has been likened to the syllables *pea body, pea body, pea body.* Lastly appear the rose-breasted grosbeak and indigo bird of the family, both of which sometimes sing from our oak.

Of the blackbirds the bronzed grackle arrives first, generally in early March, the cowbird appearing the latter part of the month. A meadow lark once paused in its flight accross the city and uttered its stridulous *zeet* from our oak. Next in this family appears that brilliant oriole, Lord Baltimore, and later the plainer relative but sweeter songster the orchard oriole.

In late April the chimmey swifts arrive but do not approach our oak until late May, when inexperienced birds may sometimes be seen to attempt to break off the strong twigs for their stick nests. Humming birds with ruby throats are often seen to alight on the oak which is next to a large trumpet creeper.

The fly-catchers are represented by three species. King-birds, common and wood pewees are all visitors, the latter almost daily during summer. That beautiful singer, as well as bird of handsome plumage, the scarlet tanager sometimes wanders into town, and on one occasion I observed one in our oak. The house wren which nests in the neighborhood is often seen.

In the grand rush of migrants which occurs from April twentieth to May fifteenth, and during which time over

one-half in numbers of all migrating birds, reach or pass us, we are visited by a large series of birds, mostly small ones, which go further north to breed. The following have been observed in our oak: Nashville, parula, yellow-rumped, black-throated green, Tennessee and Wilson's warbler and the water thrush, while the black and white creeper and Blackburnian warblers remain to nest to some extent in the county.

Among the vireos, three, the warbling, red-eye and yellow-throated, occasionally visit our tree, and all nest in the county. The blue-gray gnatcatcher, although a woodland species, occasionally wanders to our oak.

Three species, the bluejay, robin and chipping sparrow, have rested in this tree during my observations.

It will occupy too much of your space to enumerate the many species of insects which have been found feeding on the foliage or resting on the trunk or limbs of this one tree, but enough observations have been presented to suggest the value of continued notes, even on the visitors to one Oak Tree.

There are many common species of birds which have not as yet been recorded, and many of them are to be looked for and may still be added to the list. A number of birds have been seen which could not be identified, and these instances have always been ignored, the above list being exact.

THE USE OF TUBERCULIN AND MALLEIN FOR THE DIAGNOSIS OF TUBERCULOSIS AND GLANDERS IN ANIMALS.

Shortly after the announcement made by Koch of the effect of tuberculin, the product of the growth of the bacillus tuberculosis, upon man, the idea was suggested that tuberculin would be a very useful agent for diagnosing tuberculosis in cattle. This is often a very difficult matter, and the advantage of a sure method of diagnosis was at once apparent.

While it is probably true that unless the udder of a milch cow is diseased there is but little danger of the milk being contaminated with the consumption germ, the diseased animals even with incipient cases are fruitful sources for the infection of other animals as well as man.

Just to what extent man contracts tuberculosis from cattle and other animals, and *vice versa*, to what extent animals contract this disease from man is not known and would be very difficult to determine. The probabilities, however, point in favor of the fact that cattle are often the intermediate agent in the production of consumption in man.

A small quantity of tuberculin injected into cattle suffering from tuberculosis will cause, in diseased animals, a rise of temperature of two and a half to five degrees Fah., within eight to ten hours after the injection, while healthy animals for the most part do not respond to this test.

A large number of experiments with tuberculin have been conducted, especially in Germany and France, and in general with satisfactory results. Some few cases have been noted where the animals did not respond to the test of tuberculin, but upon section proved to be diseased, while a few others that were not diseased showed a slight reaction with the tuberculin. In the first cases, however, the activity of the tuberculous lesions was not demonstrated by inoculations. It is well known that old, inactive lesions may be found in animals that have been slightly diseased and recovered. In the second cases the autopsies have not always been sufficiently close to prove the entire absence of disease, as there has not been an examination of the bones and spinal column. It is further possible, that the cause of infection might be present in the animal without having reached a sufficiently advanced stage for lesions to be apparent.

With a view of making tuberculin of practical value and eventually stamping out consumption among cattle, the Department of Agriculture has begun a series of experiments, and the report of the Secretary of Agriculture for 1892, recently issued, contains a statement from the Biochemic Laboratory of the Bureau of Animal Industry, of some of the results obtained. In this laboratory a number of tests have been made as to methods of manufacturing tuberculin, and the Bureau has been prepared, for some time, to furnish tuberculin of its own manufacture to Boards of Health, Experiment Stations and State Veterinarians, for practical use.

In addition to these experiments this laboratory also manufactures Mallein, obtained from the growth of the bacillus malleus. The mallein is used for diagnosing glanders in horses and has proved exceedingly valuable. Through the efforts of the Bureau of Animal Industry, this product has been widely distributed in the States, and its use in different hands has proven very satisfactory. In many instances, by its means, the disease in apparently healthy horses has been detected and by the destruction of the animal the source of infection for valuable stock removed and considerable property saved.

As the tuberculin and mallein are made thus under government control and in one laboratory, the product is uniform in character, and can be prepared at a very much less cost than the imported tuberculin can be purchased. By the use of these two diagnostic agents the Department hopes to be able to do a great deal in the way of exterminating two dangerous diseases. Whether or not it would be practical to stamp out tuberculosis among cattle by killing all diseased or suspicious animals, is a question, but it would be possible by the use of tuberculin and proper sanitary regulations to check the advance of the disease and confine it within prescribed areas.

It is along this line of investigation that advance in the future, in human and veterinary medicine, will be made, and the Department of Agriculture in looking to a control of tuberculosis and glanders is keeping in view, not only the best interests of the agricultural classes, but of the people in general. "Bios."

NOTES AND NEWS.

It has been said that "the little red schoolhouse" was the corner stone of American civilization, and from the very force of sentiment and historical memories the country school of New England retains its hold upon thousands who may have never entered its doors In "The Country School in New England," written and illustrated by Clifton Johnson, the author describes the winter and summer terms, the scholars in their classes and at the blackboard, their punishments, their fishing and coasting, their duties and amusements on the farm—in short, the every-day life of the boys and girls of rural New England in the days of our fathers and our own. Every phase of his subject is aptly illustrated with pictures from life. There are over sixty illustrations in this book, which is to be published immediately by D. Appleton & Co.

—A scientific session of the National Academy of Sciences will be held in Albany, in the Capitol, Nov. 7, beginning at 11 a. m. Members who have papers for this meeting may send the titles to Prof. Lewis Boss, Dudley Observatory, Albany, New York. A special stated session of the Academy is called for Wednesday, Nov. 8, in Albany, to consider the President's Annual Report to Congress, and other business that may come before the Academy.

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Attention is called to the "Wants" column. It is invaluable to those who use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

MENTAL IMAGES.

BY E. A. KIRKPATRICK, WINONA, MINN.

SPENCER, in his "Philosophy of Style," decides in favor of the English custom of placing the adjective before the noun because when the word "horse," for example, is pronounced, there tends to arise in the mind a mental image of a horse, probably of a brown color, since that is most common, and when the adjective "black" follows, as in French, this image must be changed, producing hindrance. While listening to a recitation upon this well-known passage, in a high school, the question came to me: "Do people form distinct mental images when words are spoken?" I immediately obtained permission to test the matter there and later in the grammar school and in a college in the same town.

The following ten words were selected and pronounced, one at a time, the pupils being requested to write down just what came into their minds when the words were spoken: "church," "book," "drum," "tree," "horse," "dog," "chair," "stove," "man," "lamp." They were told to give the size and color, if it were visual, and if it was something heard or felt to state that fact.

The answers were various, and of all grades of distinctness and vagueness, so that the task of classifying them was very difficult. This standard was finally adopted. If the writer mentioned the size and color of the object, or named an individual or species of the general class indicated by the word, his mental image was counted as a distinct mental image, otherwise it was not. Three classes of visual images were found: (1) distinct, including all that conformed to the standard given above; (2) particular, including those of the above that were of particular or individual things; (3) indistinct images, or none. The auditory and tactile images, which were very few in number, were classified separately.

The general results for the different grades of pupils and classes of students, and the sexes are shown in table I.

It will be seen from the general average that for those persons and those words distinct visual images were found in about three-fourths of the cases. The conditions were much more favorable, however, for forming mental images than are present in ordinary reading or listening. More time was allowed between the words. A tendency to form mental images was excited by the preliminary remarks, and the fact that they were to write something tended to make them form more distinct men-

TABLE I.

	Grammar School						High School										College Students								Gen. Aver.	
	7th G.		8th G.		Average.		9th G.		10th G.		11th G.		12th G.		Average.		Fresh.		Junior.		Senior.		Average.			
	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.
No. of Persons.	12	12	13	18	25	30	22	22	21	22	9	7	8	3	60	54	14	32	13	21	16	21	43	74	128	158
Dist'nct Im'g's.	8.51	7.08	7.61	7.72	8.04	7.46	9.13	8.18	8.23	7.36	8.00	7.71	9.12	4.66	8.65	7.64	7.42	6.96	6.30	6.75	6.06	5.90	6.58	6.74	7.88	7.19
Particular.	2.75	2.91	3.07	4.50	2.92	3.66	2.40	3.00	4.00	4.27	3.00	4.14	3.00	2.66	3.11	3.68	2.85	2.77	1.77	3.75	3.75	2.23	2.86	2.90	2.21	3.36
Ind'sh't or N'ne.	.91	2.25	2.07	2.16	1.52	2.20	.76	1.68	1.66	2.50	1.99	2.00	.87	5.33	1.25	2.29	2.28	2.68	3.15	2.35	3.56	3.57	3.02	2.85	2.21	3.36

tal images. In a subsequent experiment upon about two hundred normal students, when more care was taken not to make the preliminary explanations suggestive, the number of distinct mental images was about ten per cent less, and in the case of four hundred school children considerably less than that, but in this latter case many did not understand what was wanted. When particular things are thought of the descriptions may have been given from memory, in some cases, without any distinct mental image being present, but the general term was, at any rate, translated into a particular thing which represented the class. These results do not prove that in reading three-fourths of the names call up distinct mental images, but they indicate that in a large proportion of cases there is a strong tendency to form such images, which is probably often effective in slow, careful reading.

It will be seen that the females show a stronger tendency to form mental images than the males. This is especially evident when the particular images, which are less surely distinct, are not counted. The numbers in each grade or class are so few and the ages of the members in each so different that not much importance can be attached to the differences shown in the table. It is significant, however, that among the college students, where, all being adults, age is a less important factor, and where each year they take up more abstract subjects, the tendency to form distinct mental images decreases from the lower to the higher classes. Galton, in his study of mental imagery, found that some eminent men who had spent many years in abstract studies, were utterly unable to form distinct mental images. On the other hand those who deal much with objects sometimes form mental images as distinct and vivid as the original, as, for example, the painter mentioned by Taine, who looked at his subjects when sketching the general outline, then filled in the details from the mental image he had formed.

The results classified according to the age of the subjects are given in table II:

TABLE II.

No. of Persons, (Females), -	3	5	14	21	24	9	14	6	3	2	9	8	7
Age, - - - -	12	13	14	15	16	17	18	19	20	21	22	23	24
Distinct Images, - -	7	8	8.71	8.66	7.33	8.77	7.83	7.83	8.33	4.50	6.44	5.12	6.00
No. of Persons, (Males), - -	4	8	20	16	16	7	11	18	18	7	7	5	8
Distinct Images, - -	8.25	8.75	6.75	9.05	7.47	5.00	8.00	6.88	7.00	6.85	6.40	6.83	4.37

In the case of boys of fourteen and seventeen years the average is cut down by the fact that there were several who formed no distinct mental images, though it would have been low anyway, and in several other cases the numbers are so small that only slight importance can be attached to the figures. The very high average for boys of fifteen is quite suggestive. The average for girls of fourteen is also high. It is well known that great changes take place during the period of adolescence, especially in the boy. It has been shown that it is a period of rapid growth and good health, and that it is preceded and followed by short periods of slow growth and poor health. Recent experiments have also shown that at this period there is a rapid increase in the rate of voluntary motions. These figures suggested that perhaps the same law holds for the formation of mental images as for growth, health and motion. I accordingly repeated the experiment upon about four hundred more school children. The results for boys from thirteen to seventeen were as follows:

	13	14	15	16	17
	3 7-12	3	4 10-29	3 9-29	2 3-11
and for girls:	4 8-33	3	3 1-2	3 7-23	3

I arranged in marking the papers so that I should not know the age of the subject whose answers I was classifying, hence my judgment could not have been influenced by my theory. The large number of distinct images formed by boys of fifteen compared with those of other ages, especially fourteen and seventeen, is again very marked. There is considerable probability that the law of change in the tendency to form mental images is somewhat like this. The tendency to form mental images decreases just before the period of adolescence, increases very rapidly early in that period, decreases at its close, then increases or decreases according as the occupations and studies favor or oppose the tendency. More extensive experiments and more exact methods will be required to demonstrate the law.

The words used were not all equally effective in calling up mental images, but the difference is not very marked. Table III shows the per cents for the different words with the high school pupils:

"Church," being the least general term in the list, produces the most distinct images, but a large proportion of them are particular, usually of the one the writer attends. The following are typical answers: *School Children*—"Methodist church front door," "Congregational church with a large crowd singing," "A country church with a steeple," "A large white church with people going in and out," "Word 'church' printed," "A little white church on a hill in Ovid." *College Students*—"A gothic building with spire," "A generalized type of a church building," "Pictures of the exterior color somewhat dull," "Interior of the church I have attended the later years of my life, the people gathered," "A religious organization," (none of the school children gave this answer) "Sermon or religious service," "The image of several churches in succession, the Congregational first," "A white church with a spire in the corner," "First an edifice capped with a spire, then a preacher standing before his audience," "Congregational as seen from the library this morning," "Congregational views from the N. E.," "White building longer than wide, with green shutters and a spire." "A common country church building," "Image of a light stone church situated on a hill."

Book ranks next to *church* in the number of distinct and particular images called up. The particular image most frequently suggested was of the book from which the pupil was to recite next.

School Children.—"Leaves of a reader," "Circuit Rider," "Study," "A real good novel" (how suggestive this answer), "Longfellow," "Small colored white and brown," "Daniel Webster's dictionary" (!), "Bible," "See a large red book full of poems on the table," "Large, with gold edges," "Scottish Chiefs," "A large dictionary on a rack," "The knowledge one would have if he could tell all the important events in history." *College Students*—"Reading

school," "The ordinary book form," "Food for the mind," "General idea of a book," "The thoughts of some person," "Picture of a book closed," "An object which contains printed matter," "Indefinite, stiff cover, open," "A 12mo. bound in cloth, black in color," "Indistinct form of a book," "Hawthorne's *House of Seven Gables*," "A small black book."

TABLE III.

Word,	Church.		Book.		Drum.		Tree.		Horse.		Dog.		Chair.		Stove.		Man.		Lamp.	
Sex,	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.
Distinct Images,	89.5	86.6	73.0	82.7	79.0	80.0	87.0	70.0	82.0	76.6	79.0	77.3	73.5	66.6	82.0	66.6	80.5	70.0	81.0	72.4
Particular,	76.2	76.6	58.0	66.6	29.0	46.6	26.5	48.3	24.0	30.0	18.0	36.6	18.6	33.3	16.0	36.6	40.0	60.0	16.0	36.6
Indistinct or None,	10.5	13.3	27.0	17.2	16.0	13.3	13.1	30.0	18.0	23.3	20.5	26.6	26.5	33.3	16.0	33.3	19.4	30.1	19.0	27.4

The numbers indicate per cent.

The word drum called forth remarkably few auditory images. The Salvation Army drum which had been carried through the streets every evening for some time was most commonly thought of, the image usually being visual. Drums in certain bands were next most common. *School Children.*—"Circus parade," "Large base drum with sticks on it," "Small, with a very pretty girl playing," "Small drum with silver bands," "An army," "Ear drum," "A little drummer boy in a crowd and fifers." *College Students.*—"A large noisy instrument with a man or boy attachment," "My little brother using his drum," "Picture in mind of a drum, size medium, red trimmings, stretched skin across the top, cord on the sides" (evidently this image became distinct as the writer wrote the description), "My little cousin and his drum, auditory as well as visual," "A big base drum with a man pounding on it," "A band walking the street," "Drum of my native city with name of town in black letters," "An old drum I had in my childhood," "Noise and Fourth of July procession," "Form [?] and their sound," "Image of a child's drum with red ornaments."

The word *tree* called forth images of nearly every kind of tree growing in that region and some that do not. The maple was most frequently mentioned by the school children, probably because they were specially interested in it at that time of year. The particular trees were usually of the school grounds, the college campus, or the yard at home. Although the trees were bare at that time, many of the images were of trees in full leaf.

School Children.—"Maple tree tapped, with a sap can," "The cherry tree that George Washington cut down," "Tree of life," "A maple tree tall and straight, but leaves withered," "I fancy I am sitting under it in summer time eating apples," "A tall tree with spreading branches," "An apple tree in blossom," "A tree without leaves, maple, I think," "Big trees in California." *College Students*—"A representation of vegetable life, something growing," "Green leaves and shade," "That of a dream I had last night," "A particular tree which, when I began, drawing lessons, I pictured," "Hear the rustle of the leaves moved by the wind," "Mass of foliage," "A symmetrical body," "Leafless trees, bare branches," "A large stately oak."

The word *horse* called up images of horses of all sizes, ages and colors, the particular horse thought of usually being that belonging to the family.

School Children.—"Axtell" (the noted Iowa trotter), "A bay horse attached to a red-wheeled buggy," "A horse with wings," "Geo. H. trying to hold a runaway horse," "Maud S," "Black horse in a red barn," "A black horse going at full speed," "The horse I draw pictures of," "Team I saw this morning." *College Students.*—"A black horse in a pasture," "Picture of a horse with a fine-shaped head and curly mane," "One which I saw loose on the street yesterday," "A horse travelling very fast," "Visual image of the word *horse*," "A large bay horse; I used to work with such a one," "A span of gray horses, not particular," "Pony with a saddle," "A vague image of a horse trotting down the road," "Horses struggling with a heavy load."

The answers given above are typical of the kind of answers given for the other words.

The question of what determines what one of the many possible mental images shall be called up at any particular time by a word is a very interesting one. One would naturally think, as Spencer suggests, that the image of the object most often seen would be the one called up and used to represent the class. In many cases this is true. The particular images, however, are often of objects recently seen. Again, the effect of early association is prominent, *e. g.*, a college senior thought of the

high chair he used to occupy. In other cases intensity of the impression produced by its novelty, oddity, or some emotional accompaniment, seems to be the principal cause.

It may be asked, Is it not entirely uncertain what kind of a mental image an individual will form when a word is spoken? May it not be of one kind at one time and of another the next hour or day? Galton tested himself several times under entirely different circumstances and was astonished to find in what a large proportion of cases the same thing was called up by the same word. In order to test this matter I repeated the experiment upon the senior class after an interval of a month, during which there had been a ten days' vacation. Twenty-three papers were obtained of those who had been tested before, and the answers were classified. The results were very much the same as in the first test. In the case of distinct images, not particular, the results were almost identical. thirty-five such images being called up in the mind of the boys the first time and thirty-three the second, and twenty-four both times in the minds of the girls. Upon comparing the two sets of papers individually, I found that forty per cent of the answers were identical and ten per cent were nearly so. The greatest variation was in the case of particular images, especially where recency was the principal factor in producing them. Yet I found that where one formed particular images in one case he did in the other, though often of a different thing. Those who formed distinct images in the first case did in the second, and those who formed none, or vague ones, in the first case, did the same the second time. I was surprised at this result and my confidence in my experiments very much strengthened by it. It shows that the mind works according to fixed laws, and justifies one in believing that the kind of mental images one forms are just as characteristic of his mental organization as his features and gestures are of his bodily. Were we accurate observers of mental phenomena we could recognize the language and thought of a friend as readily as we can his handwriting.

The individual differences in the tendency to visualize vary greatly and form an interesting study. They play an important part in the mental processes of some, while others do not use them at all. For convenience, we may divide people into two classes—the non-visualizers and the visualizers. So far as could be determined there is no more reason to expect one to be intelligent than the other. The following answers from two seniors illustrate two types of the first class. The first is from a rather dull student who forms concepts instead of images, the second from one of the keenest reasoners in the class —a "relational" thinker who thinks not of the thing named, but of some related thing:

Church, a religious organization.
Book, an object which contains printed matter.
Drum, a large musical instrument (round).
Tree ——
Horse, a large quadruped.
Dog, a very friendly animal.
Chair, an object generally composed of wood, used for comfort.
Stove, an iron—
Man, a being made in the image of God.
Lamp, a glass object containing a wick and oil, which is used in giving light.

Church, pews, pulpit.
Book, leaves, intelligence.
Drum, a noise.
Tree, a symmetrical body.
Horse, a beast of burden.
Dog, household pet, fights the cat.
Chair, a comfortable lounging place.
Stove, a cooking apparatus.
Man, the crown of creation, the complement of woman.
Lamp, gives light unto all that are in the house.

Of the visualizers some nearly always form distinct visual images, either general or particular, others do not always do so spontaneously when a general term is heard, but can at will. The following answers show that the writer thinks in visual images, but the images are not generally very distinct.

"Church—A particular building in another town where a certain event took place. Book—General image. Drum—An image of a drum. Tree—The image of a general tree, not any particular one. Horse—An image of a former horse of my own. Dog—Image of the general form of a dog. Chair—Image of the general form of a chair. Stove—An image of a hard-coal burner with a fire. Man—General image."

The following are the answers of a young lady who always thinks in visual terms and who generally uses the same images for the same notion.

"Church—White wooden building with spire rising from the front. Book—Image of a book, always of a dark gray color. Drum—Probably image of the first one I ever saw. Tree—Very similar to the toy tree that came with Noah's Ark. Horse—A white or dappled gray horse, always prancing. Dog—A black Newfoundland. Chair—Common cane-seated oak chair. Stove—Image not well defined. Man—Not particular, idea. Lamp—Greasy little lamp with glass globe."

The extent to which visual images predominate in most minds is quite surprising. Only about three per cent of the distinct images called up by the ten words in the list were other than visual. In a subsequent experiment upon 227 normal students 2.4 per cent of the images were auditory and 1.2 per cent tactile and motor. This does not mean that 96 per cent of these people are eye-minded to such an extent that they cannot form anything but visual images, but it shows the proportionate strength of the tendency to represent everything in visual terms.

The power to visualize (not the spontaneous tendency to do so) and the power to form auditory images were studied in another way. The normal students mentioned above were asked to think of the breakfast table at which they had sat that morning, then they answered questions as follows: (1) Have you a distinct image of it? Yes, 211; No, 10. (2) Is each object well defined? Yes, 183; No, 20; Part, 15. Do they appear in their true color and brightness? Yes, 167; No, 36; Part, 13. (4) Do they seem at a definite distance? Yes, 173; No, 43; Part, 3. (5) Can you mentally hear the voices of your companions as distinctly as you can see their faces? Yes, 84; No, 108; Part or almost, 22. These answers are very interesting, but too much importance must not be attached to them, especially the first. Paradoxical as it may seem, a person is a very poor judge as to the distinctness of his own mental images. I am convinced that persons who usually form very distinct images are as likely to say of any particular image that it is not distinct as one who has the power to form only the vaguest images. Each answers according to his own experience and standard of judgment, and the "vague image" of one may really be much more definite and vivid than the "distinct" image of another. An objective test and standard of judgment applied by some one else will give more accurate comparative results.

The relation of mental images to all psychical processes and to pedagogical problems is very interesting and important. Their relation to memory is peculiarly close, and a number of experiments to determine it were made but cannot be reported in this article.

INMUNITY AND CURE IN THE INFECTIOUS DISEASES.

BY VICTOR U. VAUGHAN.

Immunity may be natural or acquired. Natural immunity may be peculiar to the species or race, or to the individual. An example of natural immunity is that of the domestic fowl to anthrax. This animal, even at the time of coming from the shell, is immune to even the most virulent cultures of the bacillus anthracis. It is true that the chick may be made susceptible to anthrax, but this is an artificially induced susceptibility. Immunity is natural to this bird at every period of its life.

The natural inmunity which is peculiar to the individual usually comes with adult life. The young are susceptible to a given disease, but adults of the same species lost this susceptibility and become immune. The young rat is susceptible to anthrax, while the adult is naturally immune, but can be rendered susceptible by exhaustive exercise. The child is highly susceptible to scarlet fever and diphtheria, while the adult, though not wholly immune to these diseases, loses very much in susceptibility and is likely to become affected only when greatly reduced in vitality, or after prolonged and aggravated exposure to poison. The evolution of the condition of immunity in these cases is due to the natural development of the functional activity of certain cells of the body. A child and an adult are exposed to the bacillus of diphtheria from the same source. The former becomes affected, the latter does not. The germ is the same, but in the development that converts the child into the adult, the resistence with which the germ must contend has been strengthened. Artificial immunity may be induced by either of the following methods:

1. By an attack of the disease ending in recovery. Until the discovery of Jenner, this was the only known cause of immunity, and even at present it is supposed to be, as far as man is concerned, the most potent cause. It is true, I believe, that the more grave and virulent the disease may be, the greater and more persistent is the immunity that follows. I mention this in order to call attention to the fact that there is a quantitive relation between cause and effect in the production of immunity. In this method of inducing immunity, the substance of the germ itself is introduced into the body. This method found a practical application in inoculation for the prevention of small pox.

2. By vaccination with a modified and less virulent form of the infection, or by the introduction of at first a very small number of the virulent germs and successive inoculations with larger numbers. The successful inoculations against chicken cholera and anthrax made by Pasteur consist in vaccination with a modified germ, and the valuable investigations of Emmerich and his students in immunizing certain animals to swine erysipelas have demonstrated the results that may be obtained by employing the virulent germ, first in small numbers, and then gradually increasing the doses. Again, it may be observed that the germs themselves are introduced into the body, and again it is also true that the more potent the cause, the greater and more persistent the effect.

3. By one or more treatments with sterilized cultures of the germs. Immunity against the gems of typhoid fever, cholera, diptheria, tetanus, hog cholera, and several other diseases, has been secured by one or more treatments witu sterilized cultures of these germs. In answering the question, which constituent of sterilized cultures gives immunity, we must bear in mind the following facts.

a. Marked artificial inmunity to the infectious diseases has not been obtained except by the introduction into the animal of the gem substance, either enclosed in the cell wall or in solution.

b. Sterilized cultures contain the germ substance in one or both of these forms.

c. The same immunizing substance exists in the bodies of bacteria grown on solid media and killed by the action of choloroform.

d. The same immunizing effects, varying, however, in degree, are obtained with the bodies of dead bacteria morphologically intact or in solution, with living bacteria modified and reduced in virulence, and with very small numbers of the virulent germ.

With these demonstrated facts before us, I am ready to believe that the immunizing substauce is a constituent of tne bacterial cell itself, and as each kind of germ has its own peculiar poison (which in small doses confers immunity), this poison cannot come from the cell wall; nor is it really a split product of tne germ's action, but it is the essentially characteristic part of the cell--that part wnich gives to tne germ its distinctive properties. I believe that it is the nuclein.

The three methods of inducing immunity which we have mentioned reduce themselves to one and the same principle, i. e. the introduction of germ nuclein into the body.

The immunity that results from an attack of the disease is caused by the introduction of germs living and more or less virulent. That which comes from vaccination is due to the introduction of germs living but modified and reduced in virulence, or administered in small quanity; that which is obtained by one or more treatments with sterilized cultures is secured by the introduction of germ nuclein so modified that it is no longer capable of reproducing itself.

4. By treating a susceptible animal with the blood serum of an immune animal.

Strange as it may seem, the principle upon which immunity is secured when the blood serum of an immunized animal is injected into a susceptible one is essentially the same as that which holds good in the methods already discussed. A horse is rendered inmune to tetanus by previous treatment with the modified bacterial proteid of that disease. As a result of these treatments, a tetanus antitoxin is generated in some organ or organs of the horse and circulates in its blood. When the blood clots, this antitoxin is found in the serum, and if the s serum be injected into a mouse in sufficient quanity, this animal becomes for the time being immune to the tetanus poison, provided that the poison is not introduced in quantities so large that it will not be destroyed by the antitoxin that has been brought over from the horse. The immunity actually does nor belong to the mouse, it still belongs to the horse. It is stolen property and will soon be lost. The cells of the horse and not those of the mouse make the antitoxin. The mouse for the time being becomes physiologically a part of the horse, and it is by virtue of this relationship that the former is for the time being immune to tetanus.

We have seen that in all cases the cause that brings into existance the condition of immunity is a bacterial proteid. Nnw, in order that this inciting cause may induce the condition of immunity, it must act upon something. Upon what organs of the body does it act? We have many reasons for believing that the organs acted upon are, the spleen. bone narrow, thyroid and thymus glands, and possibly other grandular organs. Tizzoni and Cattani have found that rabbits from which the spleen has been removed cannot be immunized to tetanus. Supposing that the above mentioned organs are concerned in the production of immunity, in what way do they act? Do they

elaborate antitoxins, and if so, what can be said about the natnre of these antitoxins? These are questions in which I have been deeply interested for some time, and which I have attempted to solve. In this attempt, I have born in mind the fact that these organs are the source of the nucleated white blood corpuscles. Do these corpuscles contain a germicidal or antitoxic substance, and if so, what is its nature? The chief chemical constituent of nuclei is a substance called nuclein, some of the general properties of which are known to physiological chemists. Can it be that nuclein is the germicidal or antitoxic substance? Have the nucleins in general or as a class any germicidal action? As methods of insolating the nuclein are known, these questions can be answered by experimentation, and this I have attempted to do.

At first I tried to prepare an active nuclein from compressed yeast, but the results were not satisfactory. Compressed yeast contains a large amount of water and starch. The large proportion of the first mentioned constituent caused a very small yield of nuclein, and there were many dfficulties in the complete separation of the starch. There were, however two other and more serious objections to the use of compressed yeast. The first of these is due to the fact that such yeast contains bacteria to begin with, and the nuclein contained in this yeast has already been decomposed. The second difficulty lies in the fact that compressed yeast contains many dead cells, and an active nuclein can be obtained only from living, healthy cells.

From the cells obtained from pure cultures of yeast, I have obtained an active nuclein by the following method:

The cells from pure cultures of yeast are washed with sterilized water, then treated with a five per cent solution of potassium hydrate and filtered through paper. Sterilization of the paper is not necessary. The filtrate is feebly acidified with hydrochloric acid and the proteid precipitated with 96 per cent alcohol. The precipitate is washed with alcohol by decantation until the supernatant fluid remains colorless. The precipitate is then collected upon a filter, and after all the alcohol has passed through, it is dissolved in very dilute potassium hydrate (.25 to .50 per cent). This inquire nuelein hus marked germicidal effects upon the staphylococcus pyogenes aureus, albus, the anthrax bacillus, and the germs of typhoid fever, Asiatic cholera, and tuberculosis.

The following experiment will illustrate the action of this nnclein upon the bccillus of tuberculosis: A loop of tuberculous sputum, showing from 40 to 60 bacilli in each field when stained, was stirred up in beef tea, allowed to stand for twenty-four hours at 38° C. and injected into the abdominal cavity of guinea pig No. 1. Another loop of the same sputum was added to a solution of 30 milligrams of inpure yeast nuclein in .08 per cent of potassium hydrate, and this was allowed to stand in the incubator at 38 degrees C for twenty-four hours, and then injected into the abdominal cavity of guinea pig No. 2.

At the expiration of fourteen days, both of those animals were killed. The omentum of No. 1 was a tuberculous mass throughout, while No. 2 showed not the slightest evidence of the disease.

I have prepared testicular nuclein from the testicles of of the bull, dog, guinea pig, and rat. The testicles are stripped of their investing membranes as soon as removed, rubbed up and extracted repeatedly with a mixture of equal volumes of absolute alcohol and ether. Then, the testicular snbstance is digested for some days (until the supernatant fluid fails to respond to the biuret test for peptones) at 40 degrees C. with pepsin and .2 per cent hydrocoloric acid. The undijested portion which contains the nuclei is collected on a filter paper and washed, first with .2 per cent hydrochloric acid, then with alcohol. Finally it is dissolved in a .5 per cent solution of potassium hydrate and filtered through a Chamberland filter without pressure This solution is clear, more or less yellow, and feebly alkaline. On the addition of nitric acid, a white precipitate forms and dissolves colorless in the cold on the further addition of nitric acid. This nuclein does not give the biuret reaction, but does respond to the Millon test. The nitric acid solution of the precipitate becomes yellow on the addition of ammonia. This nuclein also has germicidal properties, as is demonstrated by the following experiment:

A solution of testicular nuclein of unknown strength, obtained from the testicles of a bull, was diluted with four volumes of physiologic salt solution, inoculated with the bacillus anthracis, and plates made with the following results;

Time,	Immediate.	30 min.	1 hr.	2 hrs.	3 hrs.
Number of colonies,	730	6	0	0	0

Other nucleins with germicidal properties have been obtained from the thyroid gland, spleen, and from the yolks of eggs.

These experiments render it highly probable that the nuclein-forming organs of the body have some concern in the production of immunity. The nucleins formed by these cells or in these organs pass into the blood partly in the form of multinuclear white corpuscles—the so-called phagocytes.

In order to state my views upon immunity in a condensed form, I will summarize as follows: There must be three factors in the production of immunity in an animal naturally susceptible: First, there must be an inciting or immunizing substance introduced into the body. This substance is the nuclein of the germ. These nucleins, when introduced into the bodies of certain animals, in certain amounts and under certain conditions, have the property of so stimulating the activity of certain organs that those organs produce and supply to the blood an antidote to the substance introduced.

Secondly. The organs whose activity is stimulated by these immunizing agents are those such as the spleen, thyroid gland and bone marrow, which manufacture nucleins.

Thirdly. The antidotal substance is a nuclein. The kind and amount of nuclein formed will depend upon the nature of the inciting agent and the condition of the organ or organs acted upon.

I use the word "nuclein" in a broad sense, including the true nucleins, nucleinic acid, and nucleo-albumins. By the term "nuclein" I mean that part of the cell which under normal conditions is endowed with the capability of growth and reproduction, which assimilates other proteids and endows these assimilated substances with its own properties. It is that part of the cell which gives in its individuality. Whether these nucleins while in solution and devoid of morphologic unity are still capable of assimilating allied bodies cannot at present be satisfactorily determined.

We can suppose that the process of immunizing an animal proceeds in something like the following manner:

The modified virus of tetanus is introduced into some distant part. In some unknown way, the spleen is stimulated to action and secretes a nuclein which is carried partlp in solution, partly in the form of multinuclear cells, to the invaded party of the body, and the tetanus poison is converted into the nuclein coming in contact with it, or is otherwise rendered inert. Later, a larger quantity of the tetanus poison is introduced, and now the aspleen ts more promptly and energetically than before. This promptness and energy of action are increased by exercise, and finally an amount of tetanus culture of full virulence, suf-

ficient to kill an animal whose spleen has not been subjected to this training, may ba introduced without ill effect.

On this theory, the production of immunity consists of a special education of certain cells and artificial immunity becomes essentially cellular. The differance between immunity and tolerance I conceive to be this: In the former, the of certain organs become aggressive, a special function is developed. The poison introduced is destroyed. In tolerance, there is no aggressive action on the part of any organ.

There is no development of special functions. The poison introduced is not destroyed, it only fails to kill.

Now what can be said about the relation between the principles of inmunity and those of cure? Are they the same? I think that there are essential differences. In the first place, the substances with which inmunity is induced are not applicable in the production of a cure. They are already in the body and have failed to stimulate the nuclein-forming cells in such a manner as to cause their own destruction. To introduce more of the bacterial poison after the invading virus has established itself in the system will only strengthen the invader.

If I am right concerning this differance between the agents of inmunity and cure, to what source shall we look for curative substances in the infectious diseases? Either we must introduce into the body some germicide formed by other cells, or we must employ other agencies for the purpose of stimulating the nuclein forming cells.

Blood-serum therapy offers the first of these alternatives, and now that we know that the germicidal constituent of the blood is a nuclein, blood-serum therapy will give place to nuclein therapy, and with the latter there is more hope of accomplishing good results because it reduces the size of the dose.

Now that we have learned that the animal body itself generates a germicide more powerful in its action than corrosive sublimate, and since we know how to increase the amount of this substance in the blood and can insolate it and inject it into other animals, a new theory of the treatment of diseases is opened to us.

If it be possible to kill the germs or destroy the bacterial poison after the development of an infectious disease, by the introduction of a germicde or a toxicide formed by other cells than those of the infected person, then we may expect that cures for diseases of this kind will be found in the near future. Experimentation offers the only means of ascertaining whether or not this be possible. The recently reported cases of tetanus successfully treated with the antitoxin of Tizzoni and Cattani, obtained from the blood of animals which have been rendered immune to this disease, are in accord with this principle.

If nuclein therapy fails us, we must strive to find agents that will stimulate the nuclein forming glands. This probably is the shief factor in the climatic treatment of tuberculosis, but so far as our knowledge of medicinal substances that will accomplish this result goes, we are practically and wholly ignorant.

I have used the "cure," limiting its meaning to the destruction of the germ or other poison. If we could destroy all of the bacilli in the body of a tuberculous patient, would a cure be effected? If we ever reach this desideratum. nature will probably do the rest.

CONSCIOUSNESS UNDER THE INFLUENCE OF CANNABIS INDICA.

BY E. W. SCRIPTURE, YALE UNIVERSITY, NEW HAVEN, CONN.

THE statement is generally made that the extract of *Cannabis Indica* (flowers of the Indian hemp whose leaves and resin furnish hashish) causes time and space to be greatly lengthened in consciousness. Wishing to know what is meant by these statements I obtained the prescription:

Rx.
Ex. Cannabis Indicæ 1 oz.
(P. D. & Co.)
Alcohol 20 oz.
M. Lig. Alcoholic solution of extract of Cannibis indica. One drachm contains three grains. Commencing dose ten drops containing one-quarter grain of the extract.

One evening I took ten drops as prescribed. No effects were noticed for over 45 minutes. Concluding that the dose was not strong enough I gave up the experiment for that occasion and drank a mug of beer preparatory to retiring. The narcotic action of the hops probably assisted in bringing on the effects of the dose. It is to be noted that my consciousness is very suspectible to the influence of narcotics.

For over an hour and a half, till final sleep occurred, and in a lesser degree throughout the next day, several important changes in mental life were observed. The most striking was the fluctuation of attention. The experiments of Lange (Philos. Studien, IV, 390) and of Eckener, Pace and Marbe (Philos. Stud., VIII, 343, 388, 615) have demonstrated the phenomenon as a normal condition for weak stimuli. For example, the faint ticking of a watch is alternately lost and heard. It holds good also of stronger sensations; the ticking of a clock, although loud, will vary in its apparent intensity. The immense fluctuations under the influence of hemp can be illustrated by the following case which occurred several times. A horse car is heard approaching; shortly afterward I find that the sound enters anew into consciousness; again it enters anew, and this is repeated through all the phases of approach, passage and retreat of the car. While listening to the sound, it somehow slips away, just as in Lange's experiment, and returns after a while. In describing the phenomenon I have avoided saying that the sound is heard, dies away, is heard again; all that is known in consciousness is the repeated entrance of the sound and the memory of the fact that it had been lost out of view a moment before.

The next most striking phenomenon was the remoteness of objects in their relation to myself. After the phenomenon had begun to be noticeable I wrote down on the spot the condition I found myself in. The words are: "Events seem more distant in feeling of subjectivity—events happened seem to have happened in time remotely related to the observer—apparently the time seems quite remote—yet after all it is not really longer than the usual time. Events in space are less personal, yet not further away. My feet on a cheir in front do not seem so close to me but my legs are not longer." I could estimate a period of five minutes quite correctly; I could touch objects without any noticeable error of estimation. Yet events of five minutes ago belonged to the past and objects on the table beside me seemed scarcely to be there for me to reach them. During the following day I several times noticed that a minute after seeing a place or an object, the event might as well have occurred on the previous day.

All these phenomena, in a minor degree, I have frequently observed when depressed by dull weather or by fatigue. On those occasions and under the influence of hemp there seems to be a partial loss of power of volition in general. This, I think, gives the key note to the phenomena noticed. Holding a sensation steadily under attention requires an effort, in fact, even when the sensation is strictly attended to, it unquestionably undergoes continual fluctuation of conscious intensity. Attention, even in its simplest form, the so-called involuntary attention,

includes an element of subjective reaction to the sensation; it is a phenomenon of will in its simplest stage. This decrease of will power, or reacting power, would render the fluctuations of attention greater. The remoteness in time seems to depend on the weakness of attention. As already stated, the actual time does not seem longer; events are as correctly localized in time as in space. But whenever a memory of a past event, even though it occurred only a minute ago, is called up, it seems to belong to the distant past. Memories are remoter the fainter they are. The calling up of a memory requires an act of voluntary or involuntary attention. Any weakness of will would tend to produce a weaker—and thus remoter—memory. Since we know that memories grow fainter as the time elapsed is longer, an over-estimation of the past is natural.

The remoteness of objects in space is due to a conscious or unconscious estimate of the effort necessary to reach them. When the effort is more difficult, as with fatigue, hemp, etc., its amount will be over-estimated; objects will appear remoter than otherwise although our previous knowledge of their space-relations prevents any distortion of space itself.

The drug finally produced faint illusions, chiefly ceilings decorated with colored designs, and finally sleep. It is noteworthy that the progress of the drug took place in stages, there being a continual fluctuation between loss and recovery of power.

The conclusion seems to be that among the earlier phenomena produced by *Cannabis Indica* the most prominent is a diminution of the power of subjective reaction in sensations, or a decrease of primitive volition. This leads to an incapacity for both involuntary and voluntary attention whereby sensations are dropped out of consciousness for intervals of time. The loss of power of attention also affects the memories, making them much weaker; this leads to an over-estimation of the remoteness of past events although time is not directly over-estimated. The decrease of volitional power leads to an over estimation of the remoteness of objects from the person, since to reach them would require more effort than usual.

Finally, let me suggest some lines of experiment to be performed before and during the influence of hemp: 1st. the rate of voluntary tapping to test the effect on simple voluntary movements; 2nd. graphic records of the time of fluctuation of some sound, to determine the periods of fluctuation of attention; 3rd. estimation and record of one second of time; 4th. experiments on will-time. Owing to disagreeable after-effects of the drug on my organism I shall probably be precluded, for some time, from carrying out these experiments myself.

LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as a proof of good faith.

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

SCIENCE IN THE SCHOOLS.—A REPLY.

Science of Sept. 29 contains an article by Professor Chapin discrediting the value of scientific instruction below the High School, and questioning the wisdom of placing such instruction in the grammar and primary grades. Several evident misconceptions in the mind of the writer both as to the nature and value of such science work impel me to reply. The wisdom of introducing and maintaining in the grades systematic training in the sciences, is believed to be made apparent by the following nearly axiomatic statements.

1st. The prime function of the school is to *educate* the individual in order that he may be of the greatest service to society in general and himself in particular.

2. A person has acquired intellectual culture—is *educated*—only to the extent that he has learned to use *all* his mental faculties to the best possible advantage, and has incidentally obtained some knowledge. To quote from most worthy authority, these faculties should be "like a team, which is *quick, strong* and *in harness*."

3rd, Real science teaching supplies a training absolutely necessary for complete mental development, vital, in many cases, to the highest success of the individual.

4th. The particular training cannot be said to have been obtained generally under the old regime, as is well known by those who have had to deal with the graduate of our grammar grade.

As a teacher of the natural sciences, who has been trying for some time to determine *where, what* and *how much* such instruction should be placed in the grades below the High School, allow me to present briefly the results to be accomplished and make some suggestions as to how a place may be made for it even in our already over-crowded courses. Thorough scientific training, such as may be given by skilled teachers, will yield the following results:

1. *The cultivation of the powers of observation; the ability to obtain knowledge first hand through the agency of the senses.* This, of itself, brings no special mental vigor, for savages are known with sight and smell developed to such an extent as to rival that of the beasts about them, and yet who cannot appreciate number beyond the fingers of one hand. Combine such power, however, with a mind well trained in other directions and you may expect wonders in the trades and professions.

2. *The preparation of written records of these observations in clear, accurate, concise language, supplemented with equally clear* and *accurate drawings.* In this way the quality and value of the observations are to be tested, the facts fixed in the memory and there is supplied a rigid, most valuable and so sadly needed exercise in the vernacular.

3. *Logical reasoning upon these observations, the deduction of truth* and *generalization.* Logical habits of thought and the ability to generalize, of course, characterize the mind of the scholar, but by judicious training they may be developed, and even earlier in life than is generally supposed by education. If one observes closely a bright active child of three or four years of age, he will be found to be continually forming judgments and generalizing. His conclusions are generally wrong because based upon a too limited number of observations. I have seen an *eleven weeks'* old infant make a series of observations, form three identical judgments and then arrive at a general conclusion. There has been so little in our elementary school courses to develop or in any way to call into action the reasoning faculties, that this characteristic is soon lost sight of. Arithmetic, when properly taught, gives a valuable training in deductive reasoning. but the tendency of even our best texts has been to disregard the discipline and render the processes largely mechanical.

4. *The acquisition of useful knowledge.* The amount of useful information to be obtained from a series of properly graded science lessons, extending over a period of eight or ten years, is by no means inconsiderable. A good elementary knowledge may be obtained of botany, zoölogy, geology, physiology, physics and chemistry; enough for general culture and to enable the pupil to read with some intelligence along any or all of these lines in case he must now leave school. A child of my acquaintance, before he had reached the legal school age, could point out the parts of a flower, locate the principal organs and bones of his body and could identify a dozen and a half of animals by their physical properties.

5. *A love of Nature.* Associated with a teacher enthusiastic in the study of Nature and natural phenomena, thoroughly imbued with a love of truth for its own sake, the pupil can scarcely fail to catch something of the teacher's spirit. A true appreciation, however, of the works of the Creator can come only when he, by means of scalpel and microscope, if need be, is given an insight into their *real* beauty, structure, harmony and wonderful diversity. In this most important respect they differ from the works of man,—the best of which must be viewed from this or that standpoint, in certain lights only or from a distance squinted at through a tin funnel. Nature may thus be given a new charm for the pupil, his walks to and from school, or into the country yield an added pleasure, his happiness has been multiplied by a factor, the value of which depends upon his teacher and himself, but which is always greater than unity. He now really

"Finds tongues in trees. books in running brooks,
Sermons in stones, and good in everything."

His mind engrossed in the contemplation of a plant, animal or pebble, or absorbed in the interpretation of some natural phenomenon, has little time for evil thoughts. He must grow wiser, better and more loving. I cannot agree with Professor Chapin that the collection of animals and plants and, if necessary, the "picking them to pieces" lessens in any way, the pupils' "regard for God's creatures." On the other hand, in this way is such regard most certainly developed and maintained, a bird in the hand being worth a *dozen* in the bush. This does not imply that the pupil is to *continue* his killing and picking to pieces, and my experience with boys is that those who have acquired the most intimate insight into the wonders of Nature hesitate longest before *wantonly* destroying any of her forms.

Instruction in the so-called "Natural Sciences" is peculiarly adapted to the lower grades. 1. The materials are, on every hand, directly associated with the pupils at all times, and constantly appealing to their intelligence. 2. These sciences are, for the most part, "observational," and their study admirably adapts itself to the natural development of the child's mental faculties. 3. The child takes a more active interest in everything that has been produced by Nature—that has "growed"—and especially is this true if the object is "*alive*." Were it not for this the *scientific* study of jack-knives or hairpins would serve a good purpose. 4. The collection of material takes the pupil into the open air. 5. The supplies cost nothing beyond a few lungs-full of this luxury, a brisk walk, an increased circulation and a healthy cheek-glow. 6. The information obtained contributes to the general culture of the pupil, is, at times, vital to his happiness and physical well-being, and has the advantage, *to him*, of having, in certain cases, a money-value aspect. In view of all that has been said, I would place this instruction not only in the primary grades, but into the kindergarten as well—I would go a step further and have the child make a feeble beginning while he is still tottering about his mother's knees. He is then, in reality, more of a scientist than he is given credit for. With the true inductive spirit of an original investigator he is discovering, with his spoon and ball, the laws of energy and the properties of matter—a veritable "Newton in petticoats."

Wide-awake teachers and superintendents experience no insurmountable obstacle to introducing some instruction of this nature into the already crowded curriculum. The time devoted to other subjects may be shortened by a few minutes each and fifteen to thirty minutes secured daily. It is confidently believed that the time lost in each subject will be more than made up to it through the discipline secured and the refreshed minds and spirits.

If it is not deemed wise to have daily lessons weekly exercises of thirty minutes each may be given Friday afternoons, some of the lighter subjects, as spelling, reading or penmanship giving way. This exercise may take the place each week of some one of the regular studies, changing from one to another, so that the loss to any one is imperceptible. Were I in a school where none of these methods could be put into practice, I would make the work optional and give it after school hours.

It is, perhaps, needless to remark that the entire course from kindergarten to high school should be unified and systematized. The observational sciences should come first and the experimental later. A portion only of each year should be devoted to any one science; zoölogy, botany and geology in the spring and fall, and physiology, chemistry and physics in the winter.

Whether or not our educational systems have made the failure ascribed to them by President Elliot, it is certain that much is to be placed to the debit side of the account, and it is gratifying to teachers of science to learn that the discipline he prescribes as a remedy, as well as much in addition, is fully covered by genuine science work. Pupils come from our schools with the verbal memory well trained and, if the school is of the best, some literary culture, but the majority are perfect imbeciles, as far as the use of their perceptive and reasoning faculties is concerned. In this particular they have gained but little, if any, over their childhood, while with an acquired amount of superstition, they fall a prey to imposters, quacks and sharps. A single one of the Detroit dailies carries from five to eight paid advertisements of clairvoyants who are presumably making a living upon the gullible people of that enlightened community. Some three weeks ago one of them, advertising to cure a long list of diseases, including all of a "strange and mysterious nature," was called upon to treat a boy supposed to be *bewitched*. Think of it! In this enlightened age, in a state which boasts of its educational system and almost within shouting distance of its great university. Upon the stand she admitted having no knowledge of medicine, and it required the coroner's jury to determine that she is a "fraud."

Give science a place in the grades along with the so-called "practical studies" and then shall we soon have a "survival of the fittest." W. H. SHERZER.

Michigan State Normal School, Ypsilanti, Oct. 17, 1893.

BOOK-REVIEWS.

Text-book of Geology. By SIR ARCHIBALD GEIKIE. Third edition, revised and enlarged. London and New York. Macmillan & Co. 1893. pp. xvi, 1147, figs. 471, frontispiece.

THE promised revision of this well-known work has just appeared in this country. The first edition came out in 1882 and the second in 1885. As stated in the preface, the book has been increased by about 150 pages. The value of the work has been further increased by the insertion of copious references to important memoirs and papers.

The arrangement of the matter treated is that followed in previous editions, the natural relations of the several subjects of which might well have been brought out by an introductory discussion of the philosophical classification of geological phenomena proposed by Gilbert. The sections on the characters of rocks have been largely revised and new and improved illustrations introduced. The reproduced photographs of porphyritic and orbicular structure on pp. 99 and 101 constitute a departure in text-book illustration which ought to be adhered to in

the hand-book of the future. In the matter of terminology, one notes with satisfaction the author's precision in the use of such terms as "slate," for instance, as characteristic of argillaceous rocks possessing slaty cleavage. The microscopic structure of the clastic rocks is fully up to date. The igneous rocks are treated in the light of the studies of the most advanced petrographers. Prof. Geikie, we think, rightly adheres to a simple classification of the igneous rocks into an acidic, intermediate and basic series, since he deems it inexpedient to divide them as does Rosenbusch into an ancient and modern series. Zirkel's error in mistaking plagioclase for sanidine in the andesites of the 40th Parallel Survey, made known by the work of Hague and Iddings, is noted.

Prof. Geikie thinks the geological evidence demands "an amount of time not far short of the hundred millions of years originally granted by Lord Kelvin," and he has evidently read Mr. King's admirable paper published this year (see p. 60).

In the section on Denudation, the competency of meteoric agencies to reduce lands toward a base-level is ably discussed, but the American student who has followed the advanced studies in geographic evolution published by Davis and others within the past five years will be somewhat disappointed in the retention of the phrase "plain of marine denudation" for the term "peneplain" adopted by G. M. Dawson and other writers on the great base-level of erosion in North America. Prof. Geikie maintains that the finishing touches in these table-lands of erosion are given by the horizontal planing action of the sea.

The action of bacteria in producing decay and soils is not mentioned, but this recently discovered geological agent is scarcely missed in the interesting discussion of the geological action of plants and animals. The work accomplished by cryptogamous plants is carefully reviewed and fully presented. In the discussion of coral-reefs, the views of Darwin, Murray and A. Agassiz are thoroughly presented. Prof. Geikie completes his review of the subject with the statement "that the wide-spread oceanic subsidence demanded by Darwin's theory cannot be demonstrated by coral-reefs must now, I think, be conceded."

The concise use of terms which characterizes the larger part of the work is further illustrated in the case of "laccolite" proposed by Gilbert for igneous intrusions which "have spread out laterally and pushed up the overlying strata into a dome-shaped elevation." The laccolites are thus contrasted with the simple "intrusive sheets" or "sills" which have the appearance of interbedded masses. This last term for the first time appears as a convenient designation for the numerous thin, interbedded rocks which are sometimes erroneously called laccolites. Prof. Geikie also carefully adheres to the generally accepted use of the term "*monocline*" as used by the geologists of our western surveys. The part dealing with metamorphism ought to be read by every student of geology. The section on Regional Metamorphism has been much expanded so as to embrace the advances recently made in this important branch of geological science. It is clearly pointed out that igneous rocks as well as clastic beds have been altered into gneisses and schists; and the effects of great pressure are carefully discriminated.

The chart of geological periods naturally differs in its main divisions from the plan recently proposed by the U. S. Geological Survey. The pre-Cambrian, including the Algonkian and the Fundamental complex, or all that has up to within a few years been called Archæn, is placed under the head of Primary or Palæozoic, a position which is still an undecided matter at least in this country. It seems clear that the Algonkian as now constituted is Palæzoic, as Dana has urged; but the "Fundamental complex" may yet be proved Archæn in the sense in which the word was originally intended. The Quebec group has been dropped, as it should be. The North American Pleistocene glacial periods are described under the head of Champlain, as in the previous edition, a summary which seems strange to the student of glacial geology in this country.

The book on Stratigraphic Geology is particularly enriched by abstracts setting forth the recent accessions to our knowledge of the ancient and usually metamorphic

rocks. The work of Van Hise and his collaborators and Walcott on the Algonkian and Cambrian has been freely incorporated in the present work. The author does not enter into the discussion as to the extent or importance of the supposed glacial period based upon the Baccus Marsh, Dwyka and Talchir conglomerates. The Dwyka (Africa) beds are, it is suggested in accordance with the work of a recent observer, of volcanic origin. Although Professor Geikie has made the freest use of the correlation papers recently published by the U. S. Geological Survey, it is evident that he was debarred from reference to the admirable résumés of Messrs. Clark and Dall on the tertiary and of Dr. White on the Cretaceous, since these are not referred to.

In the description of glacial deposits one misses the distinction made in this country between kames proper and eskers. as proposed by Chamberlin. No explanation of eskers is given, though American and Scandinavian geologists are generally agreed that they owe their peculiar shape to deposition within the ice-sheet, explanations varying only in regard to the place in the ice where the stream originally flowed. The question of succession of glacial epochs in North America is hardly up to date, but one could scarcely expect a writer not familiar with the ground to hazard a succinct statement in view of the present diversity of opinion in America. The evidence advanced on p. 1051 as a means of dividing the glacial period, pertains to moraines, both of which it has for some time been held are far more recent than the most ancient drift accepted by any geologists who have studied the deposits. The pit-falls into which the most careful correlators are apt to fall find an illustration in the implied magnitude of the glacial deposits on the land skirting the New England Coast. It is hardly known even in America that in the highest part of Martha's Vineyard, for instance, Cretaceous clays may be pulled up in the grass-roots, since the bulk of the larger of these islands consists of upturned Cretaceous and Tertiary strata.

In the list of authors quoted the reader gains a ready measure of the influence of American geologists on the thought of their fellow-workers abroad. The familiar names of more than a score of American geologists need not be mentioned here. The index has been much extended and includes several scientific terms not found in the last edition. The whole shows the good, readable press-work of a well known publishing house.

While the American student will find the recently published correlations papers of the U. S. Geological Survey the most valuable hand-book for this country, this great work of Prof. Geikie will be indispensable both to the teacher and the professional geologist. Not the least important part of the book consists in the bibliographic references without which a text-book can now hardly be recommended to the advanced student. It may be objected to the work that is encyclopedic rather than didactic, but in so far it is a faithful exponent of the concensus of opinion of a host of geological workers.

J. B. W.

EXCHANGES.

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I have a Beck New National monocular microscope, accessories, microtome, mounting material and a large number of fine slides. Will exchange the whole or in part for a first class type-writer or photograph outfit. A. C. Gruhlke, Waterloo, Ind.

Offered sidebloom eggs of Bulimus oblongus and exotic land and freshwater shells in exchange for Helices not in collection. Send lists to G. K. Gude, 5 Gresbach Road, upper Holloway, London, England.

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